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STUDIES ON HEVEA LATEX.

IV.—THE PROTEINS.

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IN the third article of this series (1) an account was given of an attempt to apply the carbamate method to the proteins derived from latex, and the view was expressed that a better method for the separation of protein from rubber than that of insolation was needed. A description is given below of a method which may prove useful.

If fresh latex is largely diluted with water, alcohol (ethyl or methyl) may then be added without the occurrence of coagulation (2) The addition of either acid, salt, or strong base causes coagulation, and if a base is used, it is possible to remove the rubber and to leave a considerable amount of protein in the solution.

If the resulting rubber is washed and creped in the usual way Kjeldahl determinations show a remarkably low percentage of nitrogen—two samples giving A .09 per cent Nitrogen
B .06 per cent ,,

Sample A was made from a small quantity of latex and had not been very efficiently washed—in any case the difference of Nitrogen content from that of crepe prepared in the usual way—0.3—0.4 per cent—is striking.

Preparation of Protein.—11000 ccs of latex (N. 0.26 per cent) in five successive portions were diluted approximately five times with distilled water and equal volumes of 95 per cent alcohol added, a few small clots were removed, the whole bulked, and 12 ccs of 50 per cent. NaOH solution added with vigorous stirring. The resulting coagulum was squeezed in a hand-press, the serum rapidly filtered through a large Berkfield filter, and acetic acid added to pH4.4. The precipitate

(1) M. A. J. XIII No. 6 p. 154. 1925.

(2) c. f. de Vries' Rec. d. Trav. Chim d. Pays Bas XLII. iv ST III Nos. 7 and 8.

was filtered off, washed with very dilute acetic acid and with 50 per cent alcohol, and dried (1) over H_2SO_4, to a dark brown horny mass, which weighed 8.5 grams, and had a Kjeldahl nitrogen content of 11.6 per cent and ash .7 per cent. It will be noted that this amount of protein accounts for approximately one-third of the total nitrogen in Latex—i.e. 60 per cent of the estimated total existing as protein (2) The remainder was doubtless absorbed by the coagulum and being in a soluble form, was washed away in the process of creping. The percentage of nitrogen (11.6) obtained without repurification is remarkable, and suggests that the method employed is suited for lthe purpose in view. The protein gave the zantho-proteic, Millon, biuret and Adamkiewicz reactions strongly and the Molisch reaction feebly ; it did not reduce Fehling either directly or after prolonged acid hydrolysis. Gentle hydrolysis with dilute alkali failed to split off appreciable quantities of inorganic phosphorus.

These failures suggest that neither glyco (3) nor phospho-proteins are present in the 'protein' prepared by this method. The possibility or probability of splitting has, however, to be borne in mind and further investigations on this point are in progress.

Distribution of Nitrogen.—3 grams of protein were hydrolysed with HCl and treated as in Plimmer (4) for the separation of nitrogen into seven groups, the amyl alcohol-ether method being adopted for the breaking up of phosphotungstates.

Results were :—

Amide Nitrogen	...	7.7
Humin Nitrogen	...	0.5
Arginine	...	22.4
Cystine	...	0.7
Histidine	...	12.0
Lysine	...	0.2
Mon-amino Nitrogen	...	32.2
Non-amino Nitrogen	...	37.0
	Total ...	112.8

The large arginine and small lysine figures suggest that decomposition on boiling with soda was too far reaching. The small cystine figure agrees with an observation by the writer that organic sulphur remains in the solution after removal of protein. While the absolute figures differ widely from those indicated by the carbamate

(1) It may be of interest to note that this protein before drying was readily soluble in either dilute alkali or acid and from either solution was precipated about pH 5 by acid or alkali respectively.

(2) vide M. A. J. XIII p. 156.

(3) Whitby, Plantation Rubber p. 117.

(4) The Chemical Constitution of the Proteins, Pt. 1.

method (1) they agree to the extent that no one of the three large groups—diamino, mon-amino, or non-amino predominates over the others.

The amount of mon-amino nitrogen found is larger than might be expected, but requires confirmation. Troensegaard (2) has argued that the accepted methods of analysis give a false picture of the relations between chain and ring compounds in proteins, and it should be of interest to apply his methods to latex protein.

SUMMARY.

A simple and rapid method of separating 'protein' from latex is described.

It is pointed out that further work is necessary before it can definitely be said that the 'protein' as separated is actually in the form in which it occurs.

Figures for distribution of nitrogen into seven groups are given.

V.—THE POSSIBLE OCCURENCE OF A COALESCING ENZYME.

In the first paper of this series (1) evidence was brought forward to support the view that the postulate of Whitby, Barrowcliff and Campbell of a coagulating enzyme in latex could not be maintained, while it was held that the phenomenon met with could be explained by observed changes in the electrical charges of the caoutchouc globules; it was further postulated that the protein of latex was responsible for these changes.

The writer, at the time of preparation of this paper (3), was unaware that De Vries had come to similar conclusions as to the absence of a coagulating enzyme and the part played by electrical charges and had announced these conclusions at the meeting of the Koninklyke Academie Amsterdam in January 1923. (4) Again in the Receuil des Travaux Chimiques des Pays Bas (5) in July, 1923, De Vries described further work on the enzyme question which led to a reversal of his previous views, expressed in "Estate Rubber," on the comparative unimportance of enzymes in coagulation. Thanks are due to Dr. De Vries for bringing these two papers, previously unknown to the writer, to his attention.

It should be noted that De Vries does not specifically postulate a protein coating and is inclined to minimise the importance of protein in the observed phenomena, considering that resins are more probable emulsifiers and that in any case changes in the degree of solvation of the caoutcuouc itself are probably of great importance.

(1) M. A. J. XIII, No. 6, p. 154.
(2) Uber die Konstitution der Eiswiss verbindungen—Zeitsch f. ang: Chemie 38, p. 623—1925.
(3) Malayan Agricultural Journal Vol. XI No. 12.
(4) Proceedings XXVI, 9 & 10.
(5) XLII, iv S T Nos. 7/8.

Since that time a number of papers (1), (2), (3), (4), by De Vries have appeared dealing with the presence and properties of a coalescing enzyme in latex.

These papers must be read in the original, as the very considerable amount of work carried out by their author on the question of an enzyme defies brief abstraction.

It must suffice to state here that nearly all the work has been carried out on "B"-mixture i.e. diluted latex heated to 75°C or over. The properties of such latex, first noted by Barrowcliff, have been described many times—on addition of small amounts of acid (to pH 4.0) flocculation occurs, but not coagulation. If however, small quantities of unheated latex are added either before or after addition of acid, more or less rapid and irreversible coagulation ensues.

De Vries claims that coagulation of unheated latex must be regarded likewise as consisting of two stages viz. flocculation, brought about by changes of electrical charges, and coalescence which may be produced by a number of agencies among which is an enzyme, coalase, in latex. Under normal conditions the second stage follows so rapidly on the first that it is indistinguishable from it.

This enzyme is entirely absorbed by the coagulum, but may be washed out of an alcohol—coagulum with water and precipitated with an excess of alcohol.

Excess of acid destroys the enzyme; latex to which sufficient acid has been added to bring it into the "gap" has no coalescing power on "B" mixture, though itself capable of coagulation when the acidity is reduced; latex preserved with ammonia similarly loses coalescing power.

Enzyme poisons such as H_2S or HCN have little or no effect on coalescence of acid 'B' mixture by latex.

Papain which is effective in coagulating even alkaline latex, also coagulates 'B' mixture.

Many other agencies, such as excess of strong acid, alcohol, B-Napthol, and drying are found to be effective in bringing about coalescence.

The enzyme coalase is not able to de-emulsify latex, and can only act when de-emulsification has been brought about, the coalescing action is rather slow and by no means indipensable. It is considered, however, that the enzyme is effective in ordinary estate practice.

(1) Arch. v. d Rubb. Cult. VII p. 168.
(2) " " " " " VIII p. 219.
(3) " " " " " VIII p. 233.
(4) " " " " " VIIIp. 726.

De Vries' conclusions have been criticized by Groenwege (1) who claims that the behaviour of "B" mixture can be explained as the conversion of a hydrophile to a hydrophobe colloid, and the irreversible denaturing of the proteins of latex, rendering low H—ion concentrations unavailing for coagulation, until unheated latex is added when a fresh lining layer is formed.

Groenwege also instances the occurence of coalescence in the presence of cyanide as an argument against an enzyme.

De Vries has replied to these criticisms and maintains his original views.

EXPERIMENTAL WORK.

Almost the whole of De Vries' results have been confirmed by the writer except that fresh latex has been found to have a lower efficiency than that found by De Vries. Whereas that author finds coalescence overnight with 1 pt. latex to 256,000 parts of B mixture (1 : 9), the writer finds the limit at 1 : 20,000—when the fresh latex is added before the acid, and 1/1000 when added after; this difference is however immaterial to the argument for or against an enzyme. It is admitted that there is some substance in latex, sensitive to heat, strong acids and alkaline, which can bring about coalescence in acidified B mixture. The problem is—is this substance an enzyme which functions in unheated latex or are the conditions of experiment so different from normal that no such conclusion can be drawn?

In order to prevent misunderstanding, it may be as well to state that to the writer the word 'enzyme' has a functional significance, and should be reserved for a thermo-labile catalyst which plays a part in some naturally occurring portion of the economy of the organism. The fact that some reaction, abnormal to an organism is assisted or conditioned by a thermo-labile substance present in that organism, does not, to the writer, suffice, in itself, to justify the deduction that an 'enzyme' exists for a similar, but not necessarily identical reaction.

In the article on coagulation it was suggested that the explanation of the non-coagulation of 'B' mixture was to be found in a protein heat change which results in the formation of an actual 'skin' around the globules—practically the same suggestion as that of Groenwege.

The writer does not consider that De Vries has proved his case for an enzyme because the case for an extension of argument from heated to unheated latex remains unsupported, and is in fact contradicted by the observation that 'gap' latex, although itself retaining the power of coagulation, cannot bring about the coalescence in acidified 'B' mixture; as De Vries himself points out, this shows that other changes have occurred, most probably in the proteins. Yet in developing the enzyme argument this admitted heat change is completely neglected. Similar behaviour is shown by 'B' mixture which has been rendered alkaline before heating (2), on neutralisation and

(1) Arch. v. d. R. C. 8 No. 9 p. 626.
(2) Malayan Agricultural Journal Vol: XIX No. 12.

acidification perfect coagulation follows although the heated fluid has no coalescing power on ordinary ' B' mixture. Control experiments with equivalent quantities of salt added to ' B' mixture before or after heating do not show coalescence. Both these cases suggest that if no heat change occurs, or if heat change is prevented, (or more likely carried further than usual) then coagulation can proceed in absence of ' coalase'. If this is accepted it is difficult to see the necessity for assigning an active part to ' coalase' in the coagulation of unheated latex.

An endeavour was made to throw further light on the nature of the ' heat ' change. As proteins appear to be the most likely object of change it was decided to try the action of proteolytic enzymes other than papain, the action of which is known to be complicated by a coagulative action. It is commonly said that pepsin has no action on Hevea latex ; this statement is incorrect and is due to disregard of the H—ion concentration of the medium. If pepsin be added to the latex in the ' gap' (e.g. 2 ccs of 1% pepsin to 50 ccs dilute (1 : 1 or 1 : 9) latex, acidified to pH3) coagulation follows. The same result is obtained with " B" mixture. Control experiments with boiled pepsin show no coagulation.

Trypsin.—If similar experiments are made with trypsin on slightly alkaline (pH-8.5) latex, coagulation does not follow—if, however, such latex after neutralisation, or slight acidification to pH 6.0 be heated as for ' B ' mixture, and acidified, coagulation now proceeds rapidly and perfectly. Control experiments with boiled, slightly alkaline trypsin give negative results.

It is easy to show by Kjeldahl determinations on the washed rubber that papain, pepsin and trypsin all three considerably reduce the quantity of insoluble protein—and it seems fair to regard their mode of action in promoting coalescence as prevention or removal of a ' skin' of denatured protein.

It is noteworthy that trypsin added to pH 8.5 *after* heating does not act so as to permit coalescence on acidification ; this should be considered in connection with the fact that trypsin is unable to act on many insoluble proteins.

It is interesting to note that latex treated with trypsin, like that heated with soda, shares with latex preserved with ammonia the property of coagulating very rapidly on acidification. De Vries (1), has drawn attention to this, as far as ammonia latex is concerned, and ascribes it to protein hydrolysis ; surely an argument in favour of protein as an emulsifier.

Although it cannot be concluded that De Vries is justified in arguing from ' B ' mixture to latex, it is necessary to endeavour to explain the phenomenon described. If it is taken as correct that denatured protein is responsible for the absence of coalescence, a proteolytic enzyme at once suggests itself as an obvious agent in the

(1) Arch. f.d. Rubb. Cult. VII. p.168.

production of coalescence in 'B' mixture. It is clear that such an enzyme if it exists may be expected to act only at pH 4.4-5.4, and that the task of demonstration will be complicated by coagulation and absorption.

The usual methods for identification of a proteolytic enzyme—action on fibrin, gelatin, albumen, lecithovitellin, peptone, analysis of serum after rapid and slow coagulation, dialysis and tests with ninhydrin, all failed to reveal a proteolytic enzyme. Other possibilities must therefore be considered. De Vries has pointed out that alcohol, quinin, B napthol etc. are effective; the writer has found that oleic acid or oleates are highly effective (1 part of 1% sod. oleate to 1000 of acidified 'B' mixture 1:9) producing coalescence overnight. This at once suggested an analogy with hæmolysis, but it was found that neither saponin nor curare was effective. As a result of a number of experiments it was found that the coalescing action of various organic substances on acidified "B" mixture depended on molecular weight and constitution e.g. Me-OH < Et-OH < Amyl OH = Phenol. (1)

Acetic acid < iso butyric = iso valerianic = benzoic = salicylic < stearic < oleic.

Benzaldehyde and nitrotoluoul were about as effective as phenol.

Benzol and toluol were less effective than their derivatives.

Aniline, pyridine and morphine hydrochlorides were ineffective.

Lecithin and resinates prepared both from the commercial products and from latex were moderately effective.

Castor and rubber seed oils were effective in proportion to their impurities (fatty acids).

These results suggest surface action according to Langmuir—and not mere solvent action and consequent swelling of the caoutchouc.

If this is granted, it is possible to conceive of the presence in latex of a thermo-labile, easily destroyed substance which accidently coalesces 'B' mixture and may also be expected to be a potent emulsifier for caoutchouc. Such a substance in its nature cannot be easy to identify—but as a guess we may assume a lecitho-protein, or possibly a lecitho-sugar protein complex—very rapidly broken up, and once broken up or thrown out of its natural state, irreversible

(1) The general method of experiment was to make 1-5% solutions in water or methyl alcohol, to dilute or emulsify the appropriate quantity with 10 ccs water and mix rapidly with 40 ccs of 1-8 'B' mixture. The preliminary mixing with water is essential in order to prevent instantaneous clotting at the point of addition, with consequent removal of some of the added substance.

and inactive. This irreversibility of lipin complexes (1) is well known.

De Vries (2) has argued in favour of resins rather than proteins as emulsifiers because :—

(*a*) Resin is a more likely emulsifier on Langmuir's theory.

(*b*) The quantity of protein in latex is proportional to the latex and not to the caoutchouc.

(*c*) A large part of the nitrogenous bodies may be removed by creaming, dialysis etc., without change of the coagulation phenomena.

The second and third arguments appear to be unsound as they ignore the facts that Kjeldahl determinations give no indication of the proteins as such, that methods of 'resin' determination are useless as an index of specific undecomposed substances in latex, and finally that if the proteins are interfered with by tryspin, standing with ammonia etc., the coagulation phenomena are markably altered.

The writer has previously (3) endeavoured to show that 'resins' i.e. the extracted medley of substances so called, cannot be responsible for the behaviour of latex, as their precipitation points do not coincide with those of latex.

The opposing points of view—viz, proteins v. 'resins' as emulsified appear to be admirably reconciled by the conception set forth above, of a lipin protein complex—in which the fatty acids of the lipin would attach themselves to the caoutchouc while the protein would be attracted to the water of the serum.

On theoretical grounds it is quite possible that much of the so-called 'resin' is really various break-down products of the lecithin of latex. Whitby has shown fatty acids to be an important part of rubber 'resins' and such acids are also part of the lecithin molecule. If this view should be shown to be correct, the surprisingly different acid contents of rubber (4) prepared by different methods would be explained.

Work has been initiated and will be continued, to test the hypothesis of the occurence of a lipin-protein complex.

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(1) Moran. Effect of low temperatures on hens eggs' Proc. Roy. Soc B-98, page 442.

(2) Arch. f.d. Rubb. Cult. VIII No. 5.

(3) Malayan Agricultural Journal Vol. XI, No. 12 page 365.

(4) Whitby, and Winn. The Acidity of Raw Rubber. J.S.C.I. XLII, No. 32, page 336T. 1923.

SUMMARY.

Reasons are given for disagreeing with the conclusion that a coalescing enzyme exists in latex.

The action of proteolytic enzymes on latex is described.

The influence of some organic substances on coalescence of 'B' mixture is described.

A suggestion is made of the presence in latex of a lipin-protein complex which may function as an emulsifier and also as a coalescing agent on acidified 'B' mixture.

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NOTE ON BANANA FIBRE.

R. O. Bishop.

AN attempt has been made to collect some data on the fibre which occurs in the stem of the banana plant. In the Malay Peninsula there are three species of banana described by Ridley as occurring naturally, and in addition there are a number of imported varieties which flourish and are cultivated for their fruit by native small-holders. As far as the writer is aware the banana plant is not cultivated in this country for its fibre although a few inferior specimens of banana stem strippings have been seen at local Agricultural shows.

Of the wild bananas there are only two of which the extent of their distribution appears to justify further attention at the present time. These two species are described by Ridley as follows:—

Musa malaccensis Ridl.—Stems ten feet tall or more, six inches through, leaves eight feet long, barred or splashed brown when young. The fruit is subcylindric, four inches long, yellow, and having a sweet scanty pulp. Occurs commonly in hill forests and is often found in immense quantities in the jungle.

Musa violascens Ridl.—Stems slender, eight to ten feet long. Leaves ten inches across, glaucus beneath. Spike erect, acute. The fruit is angled, one inch through, three inches long and green. Common, growing with *Musa malaccensis* in great abundance.

Fibre from Musa malaccensis, Ridl.

The fibre was prepared by hand stripping from plants growing at Kuala Kangsar. Nineteen fresh plant stems were treated, the yield of sun-dried fibre was 2.75 lbs.

Description	Colour.....	Grey to white.
	Cleaning	.Good.
	Texture	Coarse, somewhat uneven some strips.
	Length.....	...Two feet average.

Micro-Chemical Examination.—A sample of the dry fibre was digested with soda solution, washed and treated with chlorine at 0°C. The bleached material was washed with aqueous sodium sulphite and suspended in water. If the digestion and chlorine treatment are efficient the fibrous filaments when shaken with water will separate into individual fibres, samples can then be removed with ease and examined microscopically. Forty separate counts were made and the average dimensions of the ultimate fibres were:—

Mean length.....3.58 m.m. Max....5.66 m.m. Min....0.9 m.m.
Mean Diameter.....27 x 1/1000 m.m.

The form was regular, cylindrical with sharply pointed ends, under a magnification of 465 the central channel is distinct as for Manila Hemp fibres.

With Zinc Chloride and Iodine the fibre was stained deep blue, after a transient claret colouration in some parts of the slide.

With Iodine the colouration was brown.

With Sulphuric acid and Glycerine there was no colouration.

Fibre from Musa violascens, Ridl.

Fibre was prepared by hand stripping from plants growing at Kuala Kangsar. Twelve stems yielded 2 lbs of sun dry fibre.

Description

Colour.....Brown.

Cleaning.....Medium to poor.

Texture.....Coarse and strippy.

Length.....Five and a half feet average.

Micro-Chemical Examination.—A sample was prepared for examination according to the method previously described. Fifty separate counts were made and the average dimensions of the ultimate fibres were found to be:—

Mean Length.....4.40 m.m. Max...6.3 m.m. Min...2.5 m.m.
Mean Diameter...25 x 1/1000 m.m.

The form was regular, cylindrical with sharply pointed ends. Under the higher magnification the central channel was well defined.

With Zinc chloride and Iodine the fibre was stained a deep blue.

With Iodine the colouration was brown.

With Sulphuric acid and Glycerine there was no colouration.

Fibre from the Stems of Cultivated Banana Plants.

For the purposes of comparison a parcel of fibre was prepared from a mixed collection of Banana Plants under cultivation on the Government Experimental Plantation, Serdang. Strictly speaking the plants were not cultivated, in as much that the stems treated were those of plants which had been left over at the time of planting a series of observation areas.

The varieties included in the test are those belonging to the *sapientum* group, but no attempt has been made to differentiate between individuals. The age of the plants at the time of cutting was approximately fourteen months.

The fibre was prepared by stripping the stems immediately after cutting. The stripping knife used was similar to that employed in the Philippine Islands by the natives who prepare Manila Hemp.*

Yield.—The cultivated banana plant as it is cut down contains a considerable proportion of total weight which cannot be regarded as raw material for producing fibre. The crown must be removed and discarded as well as a few inches at the base of the stem. In the present instance the plants cut at the Government Plantation were trimmed before being sent to the Agricultural Department for treatment. The stems as received for stripping still contained two or more outer sheaths which had to be discarded. The proportion of wet material finally obtained in a form suitable for stripping can be gathered from the following figures.

TABLE I.

Yield of Dry Fibre from fresh Cultivated Banana Stems.

Plant number.	Total height.	Total Weight.	Weight of Stem.	Length of Stem.	Weight of stem suitable for stripping.	Length of dry fibre produced.	Weight of dry fibre.
—	feet.	lbs.	lbs.	feet.	lbs.	feet.	ozs.
1	13.7	50	42.0	7.5	21	6.1	1.3
2	13.8	70	55.5	7.7	46	5.5	2.0
3	14.5	56	44.0	6.5	35	4.5	1 0
4	12.7	45	36.0	6.0	32	4.5	1.0
5	20.0	97	66.0	8.0	51	5.0	1.5
6	19.2	62	51.0	8.7	39	4.7	1.4
7	17.7	103	76.0	7.5	61	5.2	2.4
8	18.2	83	58.0	8.7	48	5.5	2.0
9	21.2	112	79.5	9.0	64	7.0	3.0
10	20.2	85	66.0	9.5	56	6.0	1.5
11	18.7	86	67.0	9.5	54	5.5	2.0
12	17.0	89	74.0	7.8	56	5.5	4.0

Total weight of Plant cut..... 938 lbs.
Weight of stem suitable for stripping..... 563 ,,
Weight of Dry fibre obtained..... 23.1 ozs.

From a further series of twelve plants grown in the same place and treated in the same manner as those above, but at a slightly later date, the following record was made :—

Total weight of Plant cut..... 670 lbs.
Weight of stem suitable for stripping..... 409 ,,
Weight of dry fibre obtained..... 13.0 ozs.

*See Malayan Agricultural Journal Vol : 13 No. 5.

Description.—The fibre obtained from the cultivated banana stems was characterised as follows:—

Colour.....	Light biscuit to grey.
Cleaning.....	Good to medium.
Texture.....	Fine to soft, no strips, some lustre.
Length.....	Five and a half feet average.

In appearance the banana fibre as prepared at the Department of Agriculture was very similar to the good grades of "Partially-Cleaned" Manila Hemp; in particular, to the fibre classified according to the standards adopted by the Philippine Islands Official Code as "Manila Hemp Strips."* According to an impartial judgment the banana fibre was slightly inferior in colour to "Good Fair" Manila Hemp though somewhat finer. It was shorter but its appearance was superior to that of "Fair No. 1 Manila Hemp."

Micro-Chemical Examination.—A sample was prepared for examination according to the described method and fifty counts of ultimate fibres gave the following results. Figures for an exactly similar examination of "Good Fair" Manila Hemp are given side by side for comparison.

Characteristics of Ultimate Fibres.	Cultivated Banana Fibre.	"Good Fair" Manila Hemp.
Ultimate fibre Mean Length ...	4.46 mm.	4.19 mm.
Max: Length ...	6.30 mm.	7.20 mm.
Minimum Length ...	2.34 mm.	2.70 mm.
Mean Diameter ...	22 × 1/1000 mm.	19 × 1/1000 mm.
Colour with Zinc chloride & Iodine.	Transient claret passing to deep blue.	Deep blue.
Colour with Sulphuric acid & Glycerine.	nil.	nil.
Colour with Iodine...	Brown.	Brown.

* Philippine Agricultural Review, Vol. 16 No. 2 Fibre Number.

Comparative Strength of Banana Fibre and Manila Hemp.

In order to establish a comparison between them, samples of the fibre from the two varieties of wild banana and the cultivated or fruiting varieties were tested for tensile strength on a Schopper Machine. Samples of Government graded standard Manila Hemp were tested at the same time, The results are given in Table II.

Table II.

	Sample.	Number of Tests.	Mean weight of 1 metre of sample. grms.	Mean Load at Break. Kilos.	Mean Tensile Strength Kgs. per unit gram-metre.
1	*Musa malaccensis* -	10	0.5794	14.5	28.1
2	do -	10	0.4484	10.5	23.5
3	*Musa violascens* -	10	0.5944	12 8	21.5
4	do -	10	0.8055	18.5	23.0
5	Banana Fibre -	10	0.2716	9 0	33.2
6	do -	10	0.2947	9.6	32.6
7	Manila Hemp "Good Current" -	10	0.6270	27.2	42.3
8	Manila Hemp "Good Fair" -	5	0.6099	19.5	32.2

The determinations were carried out in accordance with the procedure adopted by the U. S. A. Bureau of Standards. In each test a sample consisted of 30 strands of fibre.

The breaking load was determined at both ends and in the middle of each sample, the figure recorded was the mean of three breaks. The length of fibre between the jaws of the machine at the commencement of the application of the load was twenty centimetres. The humidity of the atmosphere at the time of conducting the tests was such that the moisture content of the fibre was approximately twelve per cent of the total weight of the fibre.

Chemical Examination.—An examination of samples of the fibres was carried out according to the procedure standardised by Cross and Bevan. The results obtained are given in Table III.

TABLE III.

...	Musa malaccensis	Musa violascens	Cultivated Banana	Manila Hemp "Good Fair"
Moisture -	per cent 12.29	per cent 12.07	per cent 10.4	per cent 11.45
The following results are calculated on the moisture-free sample.				
Ash -	2.47	1.47	2.6	1.69
Water-washing loss -	1.91	1.8	6.9	2.59
Acid-washing loss -	3.25	3.03	9.5	3.16
Hydrolysis "A" loss -	18.74	17.7	21.0	15.33
Hydrolysis "B" loss -	25.62	25.0	29.3	21.83
Cellulose -	31.62	30.7	34.2	74.08

Observations.—The data which has been collected, although somewhat limited, is an indication of the superiority of fibre from cultivated varieties of banana over that obtained from the native wild varieties. Although the cultivated banana yields a relatively small quantity of fibre, yet in quality it resembles the medium grades of "partially-cleaned" Manila Hemp. From the work so far carried out it appears that fibre from cultivated banana stems would be difficult to identify if used as an adulterant of certain grades of Standard Manila Hemp.

The results indicate that the work could be profitably extended to include an examination of the fibre from particular varieties of cultivated banana plants.

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REPORT ON THE CHEMICAL EXAMINATION OF FIBRE FROM THE BARK OF TERAP, TUTOR AND BARU.

R. O. Bishop.

IT appears that the barks of the trees Terap, Tutor, and Baru are recognised by the natives of the Malayan Peninsula as sources of serviceable fibrous material and that the beaten bark of the Terap finds use as a cloth among some of the Sakai. At one time these barks were the material most largely used in the construction of the walls of kampong dwellings and the Kulit Terap still finds use among the fishing people for the manufacture of cordage and netting.

A sample of Tutor bark fibre was first examined in this laboratory in 1921, and was found to be a fibrous material of high strength and suitable for the manufacture of paper of a superior quality. Samples of Terap bark were first examined during the present year and the results were sufficiently promising to indicate the desirability of carrying out a more extended examination on further samples. For this purpose the Forest Research Officer, F.M.S. and S.S. supplied larger parcels of the air-dried bark and the present report is a record of the results obtained on the examination of those samples. It is believed that the results of a similar examination have not previously been recorded.

Description of samples.—The following notes on the barks have been furnished by the Forest Research Officer, F.M.S. and S.S.

Terap.—*Artocarpus Kunstleri.* King. A rather common tree in belukar (secondary jungle). Sometimes as much as 100 feet in height and two feet or more in diameter, but usually smaller. The leaves are coarse and roughly hairy and the bark contains a considerable amount of a white, sticky sap. The wood is of inferior quality. The tree is also found in other parts of the Malayan region.

Tutor.—*Hibiscus macrophyllus.* Roxb. A small or medium sized tree, which is of scattered occurence in belukar. Trees 40-60 feet in height and as much as one foot in diameter are found. The tree is also found in India and Java. The leaves are smooth and green above and whitish tomentose beneath. The large flowers are yellow with a purple centre and fade to a purplish colour.

Baru.—*Hibiscus floccosus* Mast. Known also by the names,—Kangsar, Kapas-Kapas, Petutu, Unchang, Bebaru. A small to medium-sized tree in belukar. Trees up to 60 or 80 feet in height are sometimes found, but they are usually much smaller. The leaves are large and coarse, with hairs. The flowers are large and bright yellow; known only from the Malay Peninsula.

Chemical Examination.—The air-dry material was brushed by hand to remove any adherent soil or mould and was then sampled by punching 2 inch squares from the ends and centres of each strip of

bark. It is important to note that the material freshly stripped from the tree is very liable to rot, unless thoroughly air-dried and in the present case some strips of bark from the centre of the parcel had to be rejected on account of their obvious deterioration. From each 100 lbs. of bark ten pounds of 2 inch squares were bulked and two separate lots of 100 grams were taken for analysis.

The chemical examination was carried out according to the standard procedure adopted in this laboratory from the methods described by Cross and Bevan*. The results obtained are recorded in table I.

TABLE I.

——	Terap.		Tutor.		Baru.	
	Per cent.		Per cent.		Per cent.	
Moisture -	13.51	10.0	13.95	12.56	12.70	12.73
Results calculated on the "Moisture-Free" Sample						
Ash -	4.15	3.61	4.60	4.23	4.32	4.34
Water Purification Loss -	6.82	7.00	8.54	5.27	4.35	4.35
Acid Purification Loss -	9.09	9.35	7.03	5.92	6.81	7.08
Hydrolysis A Loss -	26.43	18.62	15.94	10.72	18.53	13.30
Hydrolysis B Loss -	31.12	31.10	30.01	21.20	26.68	23.1
Cellulose Content -	63.7	64.5	54.20	71.0	63.00	69.5

In order to establish the significance of these figures a series of results which have been obtained by similar methods on other fibrous materials are recorded in Table II.

TABLE II.

——	Loss on Hydrolysis B.	Cellulose.
Fibre Moisture Free.	per cent.	per cent.
Prime Manila Hemp, pecto-cellulose -	17.6	76.6
Hemp (Cannabis sativa), pecto-cellulose -	14.3	77.7
Sisal Hemp (Agave sisalana), pecto-cellulose	14.0	78.2
Baobab (Audansonia digitata, ligno-cellulose	22.6	58.8
Jute, (Corchoru spp), ligno-cellulose -	25.7	63.76

* Cross and Bevan .." A Text Book of Paper Making". Page 101.

Microscopic Characteristics.—The samples were subjected to a digestion with soda and the pulp obtained was beaten until the bast filaments were separated into individual fibres. These fibres were examined for length, diameter, and micro-chemical reactions. Fifty fibres were measured from each sample, the average of the results, together with those from some other bast fibres are recorded in Table III.

TABLE III.

Fibre.	Length of Ultimate Fibre in Millimetres.			Diameter of Ultimate Fibre in 1/1000 Millimetre.	
	Average	Max.	Min.	Average	Max.
Terap -	18.0	27	9	33.3	43.7
Tutor -	3.3	4.5	1.8	25.7	28.5
Baru -	3.2	3.6	2.5	25.7	31.4
*Hemp -	22.0	—	—	22.0	—
*Jute -	2.5	—	—	22.0	—
Roselle -	3.1	4.8	0.8	28.5	—

The characteristics of the ultimate fibres of Tutor and Baru were found to be very similar; smooth round fibres with well defined pointed extremities, regular in form and, in the case of Baru, particularly regular in length. When stained with Iodine and Sulphuric Acid in Glycerine the fibres gave identical yellow—grey colourations. With Zinc Chloride and Iodine the colouration was blue, with only a transitory violet.

The ultimate fibres from the Terap bast are irregular though having a high average length. The fibre extremities are sharp in many instances but blunt round ends have been observed; this may be connected with the peculiar nodal swellings which occur regularly at intervals throughout the length of some of the fibres. Fibrillae are attached at these nodes.

When stained with Iodine and Sulphuric Acid in Glycerine the Terap fibres are coloured yellow. With Zinc Chloride and Iodine the colouration is first a wine red which, with the increased percolation of the stain, changes to deep blue.

Comparative Strength of the Fibres.—With the facilities available it was not possible to carry out any work which would serve to determine the utility of the fibrous materials for rope making. It

*Cross and Bevan. Ibid.

was however possible to subject sufficiently large samples of the three barks to a uniform treatment with soda in a rotating spherical digestor and beat out a pulp which was suitable for making hand-made "boards." The "boards" were pressed, dried and calendered and cut into strips for tests on a paper testing machine.

Particulars of the treatment, which was adhered to for the three different materials, were as follows:—

Quantity of Air-dry Bark treated ... 50 lbs.

(*a*) Digested with water to a steam pressure of 65 lbs per sq. inch for 60 minutes, then drained and washed with cold water.

(*b*) Digested with soda solution (10 lbs in 40 gallons water) at a pressure of 65 lbs. per sq. inch for 6 hours.

(*c*) The pulp was then washed with water and beaten for 3 hours.

(*d*) The beaten pulp was diluted with water and afterwards made into boards on a hand mould. The boards were dried in the open air and calendered between steam heated rolls. The average dimensions of a board were:—Length 20 inches, width 10 inches, weight ¼lb.

A test strip ⅝" wide by 12" long was cut from each board. Table IV gives the results of breaking thirty strips from each material on a Schopper paper testing machine. The distance between the jaws of the machine at the beginning of each test was adjusted at 4".

TABLE IV.

Material.	Mean Thickness of Test Strip	Mean Load at Break.	Mean Tensile Strength	Coeff: of Deviation from Mean
	inches.	lbs.	lbs. per sq. inch.	per cent.
Terap -	0.0212	9.46	725.6	20.27
Tutor -	0.0295	11.19	607.6	18.71
Baru -	0.0393	12.33	520.6	15.25

Separate portions of the beaten pulp were used in small trials for bleaching. The bleached pulp was not examined quantitatively. The colour of the bleached pulp, relating to the consumption of chlorine, was good and it should be possible to produce a satisfactorily bleached paper from one of the three barks.

Conclusions.—The Tutor and Baru barks are almost identical in chemical and microscopic characteristics and appear to be suitable for making a paper, of good quality.

The Terap bark, although chemically similar to the Tutor and Baru, has a much longer ultimate fibre. This is comparable with Hemp and it appears from the results of this examination that the Terap bast after suitable treatment might be utilised for some of the same purposes as Hemp. The promising characteristics of this fibre indicate the desirability of investigating yields and the possibilities of obtaining supplies from saplings and young trees of known ages.

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YELLOW PHOSPHORUS AS A POISON FOR THE DESTRUCTION OF WILD PIG.

B. J. Eaton.

ACCORDING to the Administration Report for the State of British North Borneo 1924 (pages 9, 27 & 29) a preparation manufactured in Sourabaya, Java and imported into Sandakan at a cost of $5.50 C.I.F. per 10 lb. tin has been used with considerable success for the dessruction of wild pigs, which are a serious pest in British North Borneo.

A sample of this preparation has been forwarded to the Department of Agriculture as the active ingredient has been found to consist of yellow phosphorus.

It is well known that yellow phosphorus is a virulent poison to mammals and is used in pastes to destroy various animals. At least one proprietary rat poison contains yellow phosphorus as the active ingredient.

When dissolved in oils or fats, the phosphorus is more effective since oils or fats assist its absorption or ingestion. Preparation of a phosphorus bait :—A satisfactory paste can be prepared according to the following formula and at the cost shewn.

		$	cts.
Phosphorus (2 ozs)	...	0	30
Flour (40 ozs = 2 catties)	...	0	26
Sugar (20 ozs = 1 catty)	...	0	10
Coconut oil (40 ozs = 2 catties)	...	0	56
Total cost	...	1.	22

The total cost per 10 lb tin, including fuel and labour required for preparation should not exceed $1.50.

The mixture is prepared as follows :—

The phosphorus is cut into small pieces, not larger than the size of rice grains and mixed with 50 ozs (2½ pints) of boiling water. The flour (tapioca starch can be used in lieu of flour) is then added and the mixture well stirred and allowed to cool. When nearly cold, the oil or fat (coconut oil is probably the cheapest and most suitable fat for local use) and sugar are added and the mixture is well stirred to incorporate or emulsify the fat with the remainder of the mixture. The quantities given in the formula above, together with the water, produce about 10 lbs of the preparation.

The paste may be spread for use on any suitable medium, such as bread, coconut meat, etc. or made into balls by adding more flour, starch, coconut or other oil seed cake or meal.

Warning :—Yellow phosphorus is a dangerous chemical and requires careful handling under good supervision. The inhalation of the fumes, when phosphorous is exposed to the air, and the handling of the chemical may cause poisoning if care is not taken.

Secondly the chemical is exceedingly inflammable when exposed to air and should always be kept under water and preferably cut into small pieces under water.

If the mixture is prepared locally, it should be made preferably in an open shed under the supervision of some person who is acquainted with the dangerous and poisonous character of the chemical and who has been trained in the handling of it.

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NOTE ON *SPHAERONEMA FIMBRIATUM.*

A. Sharples.

THE writer's attention has been drawn to a short note (1) in Phytopathology, Vol. 13, 1923 page 56 respecting the true systematic position of this fungus, the cause of "Mouldy Rot Disease of the Tapped Surface" of *Hevea brasiliensis* (2). For the benefit of other disease workers in Malaya the note is published below :—

> "The fungus known as *S. fimbriatum* has been described as having three forms of asexual spores, two of which are borne on free conidiophores and a third in a long-beaked pycnidium. Examination of embedded and sectioned material has shown that the supposed pycnospores are ascospores which are apparently liberated within the perithecium by the early disintegration of the ascus. The ascospores are produced by free cell formation within the ascus, each ascus at maturity containing typically, eight spores having a single well defined nucleus. The perithecia originate in a hyphal knot, arising, at least, in some cases, from the intertwining of branches from two distinct hyphal strands. The taxomomic characters place the fungus in the genus *Ceratostomella* and the specific name *C. fimbriata* com, nov, is therefore proposed for it.

(1) Elliot, A. John—The Ascigerous stage of the Sweet Potato Black-Rot fungus.

(2) South, F. W. & Sharples, A.—"Mouldy Rot, Bulletin No. 37, Department of Agriculture, S.S. & F.M.S.

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NOTE ON EPIPHYTIC GROWTHS ON RUBBER TREES.

A. Sharples.

IN the latest issue, October 1925, of the Bulletin issued by the Rubber Growers' Association, attention is drawn to the above subject by Mr. H. Pinching, who mentions a statement made in a lecture given by the writer, under the auspices of the Incorporated Society of Planters at Kuala Lumpur, to the effect that attempts to remove epiphytic growths from rubber trees in *Ceylon* had led to a big increase in number of cases of Patch Canker.

The present note is written in order to prevent misunderstanding amongst Ceylon contemporaries. The statement made was with reference to S. India and taken from a report by R. D. Anstead, and the insertion of Ceylon for S. India is probably a mistake on the part of Mr. Pinching or the editor of the Bulletin. The lecture is printed in full in "The Planter," Vol. VI. No. 3 Oct./1925.

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REVIEW.

The Plantation Rubber Industry in the Middle East.

DAVID M. FIGART.

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THIS is the second of a series of three books on crude rubber, the first of which "Marketing of Plantation Rubber" was published early in 1924, and the third of which has yet to be published. The present volume deals with the economics of the production of rubber in the Middle East; which—as is pointed out in the Preface—produces 96% of the rubber of the world. Bearing in mind that the area of rubber in Malaya is half the total for the Middle East, the problems touched upon and the comparisons drawn between one country and another must be of moment to all in Malaya whose interests are centred in this industry.

The records in this work take the reader up to February 1924, while subsequent information of a statistical nature is embodied in the Introduction.

The book is less the opinions or conclusion of the Author than a compilation of the official and non-official records on rubber, together with a review of the problems bearing on the subjects, and stating in many cases the opinions of collections of men in rubber producing countries. The criticism may be advanced that nowhere in the book does the Author make definite deductions, but leaves the reader with a mass of facts and figures—most valuable themselves—from which he may draw his own conclusions. Were it not for the fact that on page V one is promised such conclusions, the reader would be content to place the volume on his reference shelf.

Mr. Figart is to be congratulated on the ability with which he has marshalled his facts and figures, and the excellent arrangement of the sections, which enables the reader to refer a problem as it applies to a particular country, or to the industry as a whole.

The different points of view in which the industry is reviewed are:—financial aspects, general problems, reports on individual countries, native plantation rubber industry in Sumatra, statistics, and a summary: in addition to which there are 26 pages of "Production illustrated", which might with advantage have been omitted from a work of this description.

The sections on the financial aspects of the industry; reports on individual countries; native rubber; and statistics embrace the valuable records. Mr. Figart's book is perhaps the most noteworthy production on the subject that has appeared for some time, and will be

found of great value to the large public interested—from one standpoint or another—in rubber; and for those who wish to investigate any question more fully than is possible in a work of this size, the excellent bibliography, which is included, will prove of great use.

But where a book of 300 pages is made to cover as much ground as does the present volume, there are sections which are bound to call for criticism. The section dealing with "Diseases and Pests" calls for comment in that the information contained therein is so scanty as to be almost misleading. However, Malayan planters are well-grounded in their knowledge of "Diseases" of Hevea, and the mistakes in the section above-mentioned are not likely to escape their notice. Even a specialist on "Diseases" of *Hevea brasiliensis* could not convey information of much value in three or four pages, which is the space allotted to a resumé of the disease problem in all the Rubber Growing countries of the Middle East. The chief criticism to be made is that the present volume would have gained in value by the omission of such short references to complicated technical problems; many of the problems connected with all branches of the industry are still debatable and opinions vary considerably from year to year as more information is gained. It is obvious, that under such conditions, great care is necessary when condensing the views of authorities on technical problems, and in this particular the sections dealing with technical problems are not up to the standard of the rest of the volume.

D. H. G.

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